ILLINOIS OBSERVING NANOSATELLITE (ION)

University of Illinois Urbana-Champaign

ILLINOIS TINY-SAT INITIATIVE (ITSI)

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OVERVIEW

How ION

- Educates and develops interest in space engineering
- Brings flight experience to the space technology development community
- Performs a focused earth science exploration mission

ION MISSION

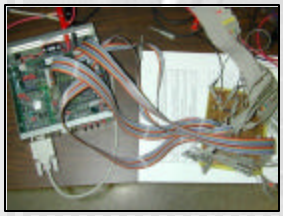
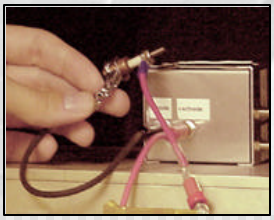
- Education
  - Provide a multidisciplinary engineering experience
  - Give students familiarity with project management
  - Develop interest in space engineering

ION MISSION

- Technology
  - Primary
    - Space qualification of vacuum arc micro-thruster propulsion system for Alameda Applied Sciences Corporation
    - Space qualification of Tether Applications Inc. Small Integrated Datalogger (SID) single-board computer
    - Development of an active, 3-axis magnetic attitude control system
  - Secondary
    - Demonstration of on-board CMOS camera capabilities
- Science
  - Investigation of airglow layer of Earth's atmosphere through use of an on-board sensor [Photo-Multiplier Tube (PMT)]

Educational Mission
Multidisciplinary design experience

- Involves three departments
  - Aeronautical and Astronautical Engineering
  - Electrical and Computer Engineering
  - Computer Science
- Learning
  - How to coordinate efforts amongst a large and diverse group
  - Communication across discipline lines
  - An appreciation for other engineers' ideas
  - Versatility and flexibility

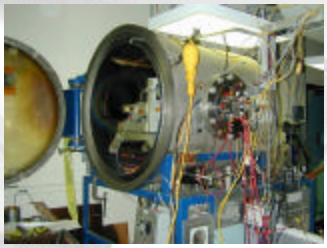




Educational Mission
Project Management

- Completely Student Led
  - Six subsystems with leads
  - Leads comprise management group
- Learning
  - Managing and working with people
  - An appreciation for management of large projects in general

Educational Mission
Develop interest in space engineering

- Excitement of putting something into space
- Introduction with the challenges involved
- Contact with the space community

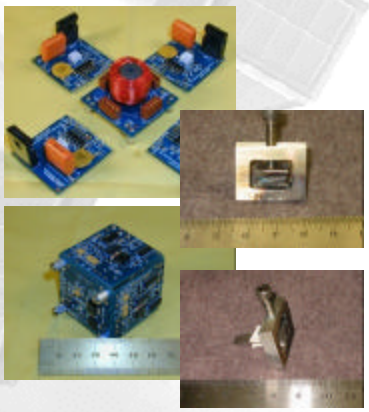


Technology Mission
Space qualify VAμT

Alameda Applied Sciences Corporation

Pulsed Electric "Vacuum Arc micro-Thruster"

- Uses electrical energy to accelerate inert solid fuel (Aluminum)
- Pulsed operation allows various thrust and power
- Very low mass

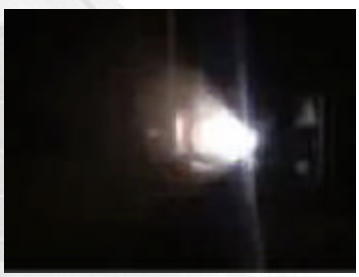


Technology Mission
Space qualify VAμT

- Thruster heads
  - Cylindrical or "BLT"
  - BLT design chosen due to higher reliability
  - Current design uses satellite frame for propellant in a **self-consuming** fashion

Technology Mission
Space qualify VAμT

- Utility
  - Attitude Control
  - Orbit Maintenance
  - Orbit Transfer



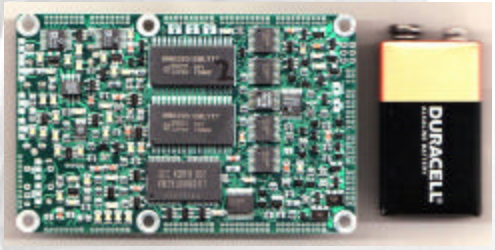
Technology Mission
Space qualify VAµT

- Verification Experiments
  - Current Sensor
    - Sensor to detect flow of current to thruster head
    - Indicates if power is being supplied correctly
  - Attitude Determination
    - Measure any changes in attitude caused by use of propulsion system
  - Propellant Deposition Monitor
    - Ceramic wafer lightly coated with metal
    - Back-splash from thrust head accumulates on wafer
    - Resistivity level monitored

Technology Mission
Space qualify SID

Tether Applications

- Small Intelligent Datalogger (SID) by Tether Applications used for flight computer
  - Features
    - Hitachi SH7045F 32-bit RISC microcontroller
    - Low power: 15 MHz at < 0.5 W
    - 1.2 MB RAM, 8 MB Data Storage



Technology Mission
Space qualify SID

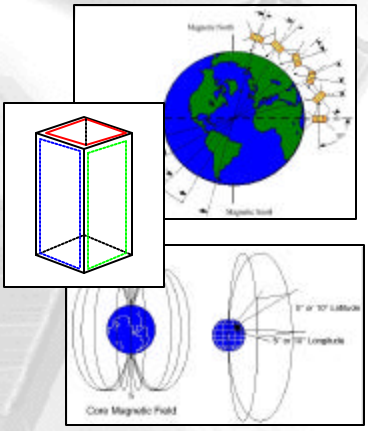
- On-board facilities
  - Low-grade gyros and accelerometers
    - Confirmation of attitude information
  - Redundant alarm clocks
    - Keep time
    - Scheduling
  - Temperature sensor interface
    - Can measure temperatures in over 60 locations throughout the satellite
  - CMOS camera interface
    - Collect images from the PhotoBit PB-300 based camera

Technology Mission
Space qualify SID

- Additional resources
  - 10-bit A/D, multiplexed many ways
    - Read solar array voltages, current sensors, etc.
  - Serial peripheral
    - Communicate with communication system
- SID Rad-hard feature
  - Overcurrent protection circuitry
    - Power cycles the computer upon unexpected current increase
- Software development
  - Mostly in C/C++
  - Using free and familiar GNU development tools

Technology Mission
Develop 3-axis attitude control system

- Actuators
  - Free air torque coils
- Sensors
  - Primary
    - 3-Axis Magnetometer
  - Secondary
    - Rate Gyros
    - Accelerometers
    - Solar panels
- Software
  - Readings referenced against model of magnetosphere for attitude determination

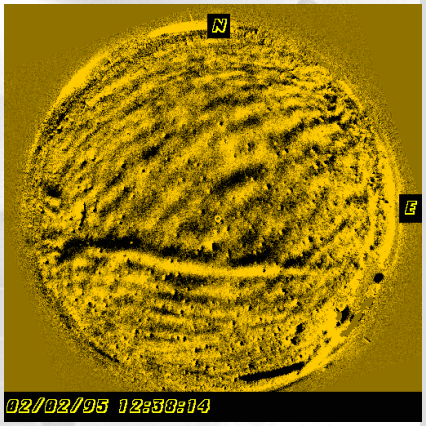


Technology Mission
Demonstrate CMOS camera

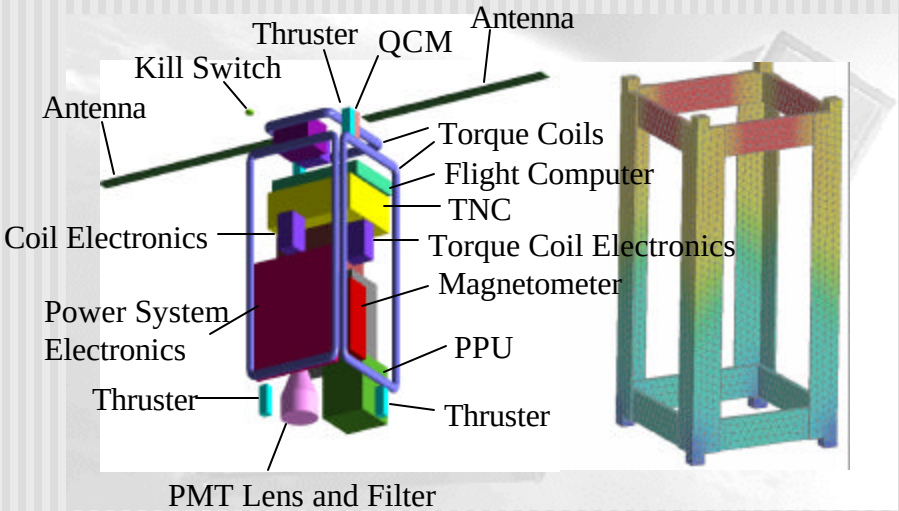
- Equipment
  - Photobit PB-300 Camera
  - SID camera interface
- Purpose
  - Additional tool for attitude determination
  - Pictures from our satellite will make for great PR

Science Mission
Investigate Air Glow Layer

- Image Air Glow Layer at 760nm
  - Study wave structures
  - Unable to image from ground due to absorption
- Equipment
  - Photomultiplier tube using photon counting technique

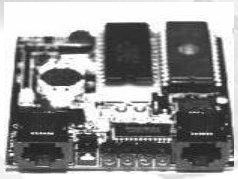


Support
Structure



Support
Communications

- Modified COTS parts
- 2W @ ~437 MHz in amateur radio band
- 1200 bps AFSK packet (AX.25)
- Half duplex
- Expected 150 KB/day with one ground station
- Two monopoles phased 180 deg apart

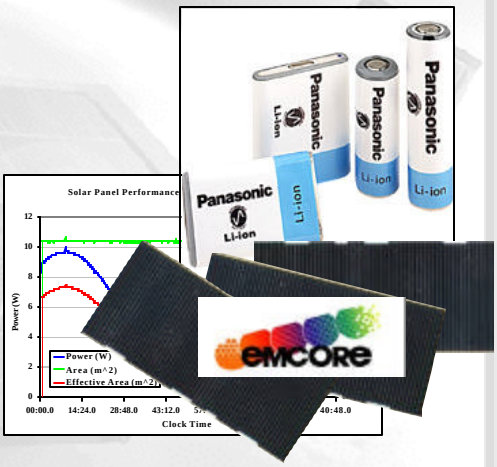


Support
Ground Station

- Amateur radio satellite ground station
- 440, 1296, and 2400 MHz capable
- Automation for optimal use of short pass times

Support
Power

- Emcore 26% efficient cells
- Panasonic Li-ion batteries
- Power use will be carefully scheduled
- Expect 7Wh/orbit from solar cells



Summary

- Education
  - Exposes budding engineers to space engineering
  - Project management experience
  - Interdisciplinary interaction
- Flight experience for space technology developers
  - Alameda Applied Sciences VAµT propulsion system
  - Tether Applications Small Integrated Datalogger
    - Many commercial parts
- Technology
  - 3-axis control
- Science
  - Airglow layer study